Urban Climate 26 (2018) 244–257

Contents lists available at ScienceDirect

Urban Climate

journal homepage: www.elsevier.com/locate/uclim

Perceptions of mountainous people on climate change, livelihood practices and climatic shocks: A case study of Swat District, Pakistan

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ARTICLE INFO

Keywords:
Climate change
Temperature
Precipitation
Livelihood practices
Climatic shocks

ABSTRACT

This study examines the association among perception regarding climate change and climatic shocks with a set of socio-demographic variables like age, education, occupation, annual income, socio-economic status and land. Random sampling method was followed to conduct household survey, a total of 279 households were interviewed from rural mountainous areas of Swat District (Pakistan). For this purpose, structured and semi-structured questionnaire was designed to gather the household information. Perception analysis revealed, large number of participants (75%) are of the opinion that present climate has substantially changed in their area compared to previous years. Findings of bivariate model showed significant impact of age, education, income, occupation, land ownership and socio-economic status on local community's perception regarding climate change in addition to climatic shocks. Furthermore, land ownership, socio-economic status and crop sowing appeared as significant predictors of rainfall decrease perception. Similarly, these variables along with water source efficiency in the area were also found significant with perception on temperature rise. Our findings clearly discern a falling trend in earnings in recent years for Swat District which local people connects with influences of changing climate. Hence we suggest local government to intervene and enhance Swat community's livelihood capacity to adjust from climate shocks.

1. Introduction

Climate change has tremendously damaged the whole world, specifically the South Asian countries because common people in this region are considered extremely vulnerable to climate change impacts whereas their common awareness to adapt and mitigate these impacts is reasonably low. Pakistan is one of the most important South Asian countries and has been extremely influenced by numerous impacts such as; drought, increased temperature, pest-diseases, health problems, seasonal and lifestyle variation and it has the potential to continue doing so in future (Hussain et al., 2018). The scientific data has presented that climate change is a global challenge for humans and their socio-economic activities, food security, health and livelihood (Amjath-Babu et al., 2016; Clarke et al., 2012). The major reason of global climate change is the emissions of greenhouse gases (GHG) that results in warming of the atmosphere (IPCC, 2013) and the most important sources of rise in the GHG emissions are anthropogenic activities via fossil fuel

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https://doi.org/10.1016/j.uclim.2018.10.003
Received 20 March 2018; Received in revised form 19 October 2018; Accepted 22 October 2018

combustion (Ullah et al., 2017; Ullah et al., 2018), industrial production processes (Yousaf et al., 2017a), agriculture and forestry, human society, and vehicle usage (Huang et al., 2016). These GHG emissions contain carbon dioxide (CO_2) gas (Yousaf et al., 2017b), and also some other non-CO_2 greenhouse gases (such as CH_4, N_2O, HFC, PFCs, and SF_6). Globally environmental, economic and social issues are becoming inferior due to climate change. Various research information on climate point out that in recent few years, it has drawn a lot of attention and it's not merely for the reason that the globally unmatched determination of irregular low amount of precipitation (Tarhule and Lamb, 2003; Mengistu, 2011), but in addition to small financial capability of the exaggerated countries to tackle the demoralizing climate change impacts (Shahid, 2010a). Extreme climatic event like drought, resulted from these devastating climate change impacts is commonly supplemented by environmental turn down, livestock herd's destruction, mass movement, prevalent scarcity of food and enormous failure of human lives in Africa (Tarhule and Lamb, 2003). Continent of Asia is too exposed to these havoc climate change impacts. Asia was the mainly disaster-impaired area throughout the duration from 1975 to 2006 in all over the world. This disaster had negatively affected the people up to about 89%, results in 57% of entire deaths and about 44% of the financial damage (Asian Development Bank, 2010). Once more, the area faces some frightening challenges from socioeconomic and environmental point of views in its attempt with regard to shield precious natural assets/resources.

There is a high risk of food security in the continent of Asia, owing to excessive degradation of ecosystem and land. Quality of air and water is deteriorating in this area with a constant rising in utilization and related waste have added to the exponential increase in accessible environmental problems of the region (United Nations Framework Convention on Climate Change, 2007). Soils are also vital to food security and variation in climate has threatened the food security through affecting the soil property (Brevik, 2013). Soil is one of the world's most significant natural resource and major component of the life-support system in terrestrial environment (Yousaf et al., 2018). This region is extremely vulnerable to natural shocks and hazards, for instance the Ocean Tsunami came in India in 2004 along with the marvelous cyclone Sidr within Bangladesh in 2007 which overstep preceding report in provisions of its exposure and velocity of wind (Shahid, 2010b).

Pakistan has a warm climate and hence is particularly exposed to climate change, and higher temperature is expected here as compared to the globe average due to its geographical position. Its economy is mainly based on agriculture and therefore highly climate sensitive; and since the country faces increasingly larger risks of floods and extended droughts due to unpredictability in monsoon rains. About 60% of its area receives $<$ 250 mm of rainfall per year and 24% receives between 250 and 500 mm, because its land area is typically arid and semi-arid. Its main rivers are primarily fed by the glaciers of Hindu Kush-Karakoram-Himalayan (HKH) which are reported to be retreating rapidly due to climate change. Under the actions of all these factors the water, food and energy security of the country are under severe threat (Robert et al., 2009). Floods, cyclones and droughts become more severe and/or more common across the region due to climate change, hence they already have a massive impact on South Asia (Parry, 2007).The 2010 floods in Pakistan were the worst in the region since 1929, affected about 20 million people across the country (Oxfam, 2009a; Oxfam, 2009b).

The data indicate that over the last 25 years, temperatures have increased at a rate of 0.19 °C per decade, which corresponds with significant rise in global levels of CO_2 emissions from fossil fuels combustion. In 2008, those emissions were 40% higher than in 1990 (Allison et al., 2009; Roco et al., 2015). Moreover, a recent study shows that there has been an extraordinary warming in the world over the last 1500 years (Marcott et al., 2013). Variations in rainfall cycles, resulting in droughts in some parts and flooding in others, are influencing agricultural production in Latin America, Africa and Asia (Clements et al., 2011), and these variations are being perceived by affected populations around the world. Extensive efforts have been made over the past 20 years in order to discover how the community understands climate change in North America and Europe, however, very little is known about climate change perceptions in developing countries (Vignola et al. 2013; Retamal et al. 2011). AGU (2013) opposes that climate change is an extensively accepted phenomenon and that its influences fluctuate throughout the globe. However, a prevalent perception in many agricultural regions is that temperature is rising whereas precipitation is declining. Descriptive proof supporting this perception for Asia is delivered by Piya et al. (2013); Halder et al. (2012); Lata and Nunn (2012); Manandhar et al. (2011). In the event of Africa, support can be found in Clarke et al. (2012); Silvestri et al. (2012); Osbahr et al. (2011).

Studies related to climate change have mainly focused on the biophysical evaluation of climate change and its possible consequences on energy, water and biodiversity in the past two decades (IPCC, 2007). A small amount of work has been carried out on the socioeconomic responses toward climate change regarding perception of human attitudes, values and beliefs. Only recently have the perceptions of human toward climate change become one of the most important tools used to observe climate impacts on human compliance and transformability (Chaudhary and Bawa, 2011). Perceptions of people on climate change can be regarded as a critical involvement to environmental problems, agricultural production and possible solutions (Weber, 2010). Those people who are involved in agriculture/farming system have more knowledge about impact of climate changes, since climate has a massive influence on production and yield of crops. In scientific literatures, there is an increasing consensus that the higher temperature and fluctuating rainfall levels caused by climate change will decrease crop production in many countries over the coming time periods (Stige et al., 2006; Falco et al., 2011).

The knowledge and information on how climate change and climatic shocks are impacting the livelihoods of rural mountainous people, is inadequate and poor. How different groups of wellbeing are impacted by climate change and how these people are responding to climate change impacts. It is very important to analyze and assess the climate change impacts on such an area where mostly the people are poor. This work accounts regarding a research work which looks at the climate change impacts on rural mountainous people living in District Swat region in Pakistan. Perception of Swat rural mountainous people on climate change impacts on livelihood practices and climatic shocks differ by means of their socio-demographic variables like age, occupation, education, income, land ownership and socio-economic status.

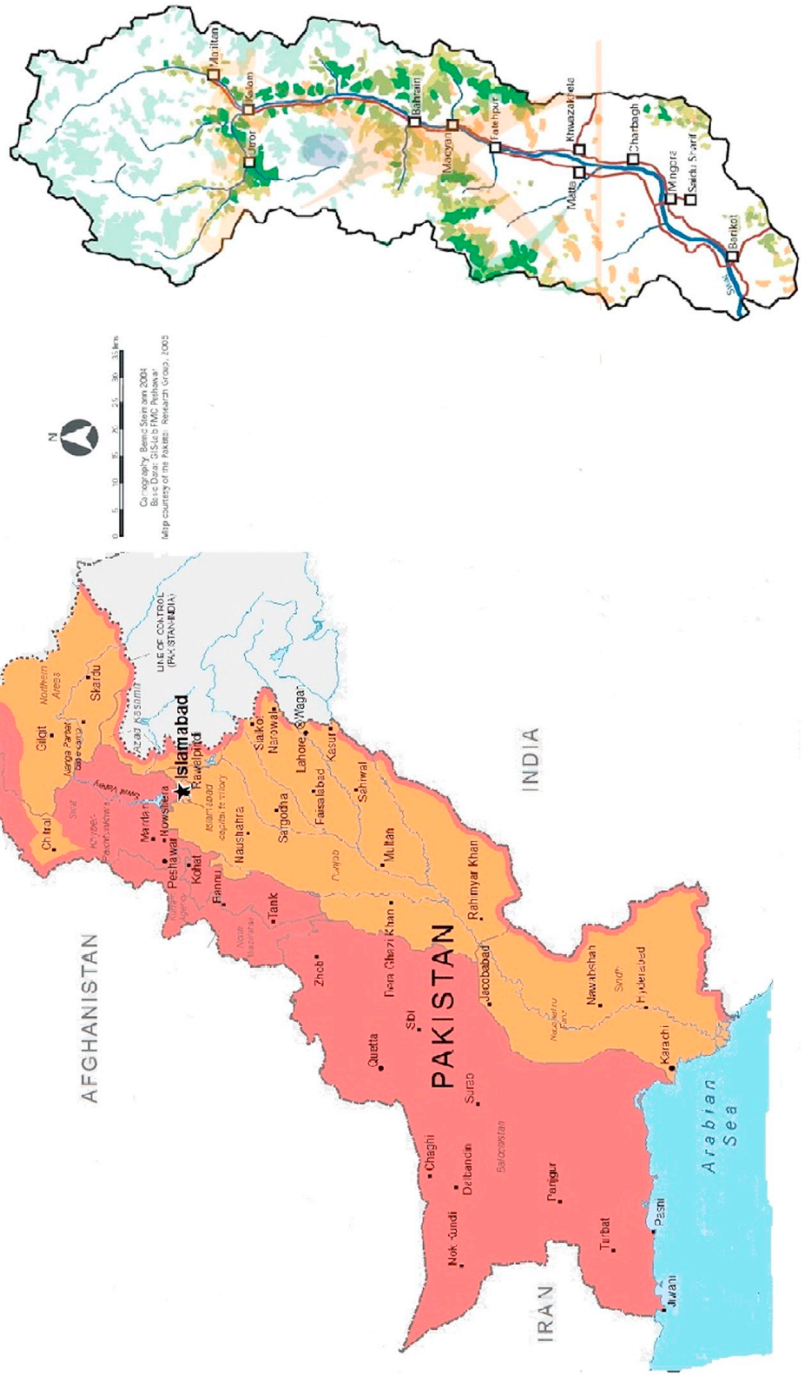

Fig. 1. Map of the study area.

2. Materials and methods

2.1. Overview of the study region

District Swat is a mountainous area having different elevations above the sea level, ranging from 600 to 6000 m, from South toward North foothills of mountainous Hindu Kush range. It occupies an area of 5337 sq. km, with total forest cover of 497,969 acres mostly comprising of Pine tree species. Geographically district Swat is located at 34°–36° North Latitude and 71°–73° East Longitude in the north of Pakistan having mountains in its surrounding with an elevation ranging from 390 to 650 m above the Mean Sea Level (Govt. of Pakistan, 1986) (Fig. 1).

The study area has a sum of population of 125,760 of which about 648,008 and 69,594 are male and female, respectively (NIPS, 2002). The area has rich water resources in the form of Swat River. It has also many physiognomic features like glaciers, forest, plains and rich in ecological resources like flora, fauna and medicinal plants and herbs. The agriculture land is broadly divided into irrigated and rained. The rained land produces one crop per season. The most important crops cultivated in the area comprise of wheat, maize, rice, potatoes and fodder. The average rainfall is around 800 mm with about 431 mm in June-September (Khan et al., 2018). District Swat is situated in the Temperate Zone, therefore, the weather here is more vulnerable to all the climatic factors like “latitude, altitude and rain bearing winds”. Most of the rainfall is received during the period of monsoon (June to September). The minimum and maximum temperature of the area ranges from −5 °C to 39 °C, recorded in Weather station Saidu Sharif (Rashid et al., 1999). The mean relative humidity ranges from a minimum of 40% in April to a maximum limit of 85% in the month of July. The climate of the area in general can be grouped as sub tropical in the Southern part while it is Mediterranean in the northern parts (Aslam et al., 1991).

2.2. Development of questionnaire

For the development of climate change knowledge-perception questionnaire, we reviewed literature on climate change, climatic shocks, climate change impacts on livelihoods, perception, attitude and behavior measures in relation to climate change. We also communicated experts in the field to check for availability of a valid tool to measure climate change knowledge. All the perception questions on climate change or climate change impacts on livelihoods had responses using various Likert-type answers such as ‘Yes’ or ‘No’.

2.3. Data collection

A survey of households in Swat rural mountainous community was carried out in April 2013. A sum of 279 households were randomly sampled and interviewed through a semi structured questionnaire which was predesigned. A semi-structured draft questionnaire was developed and confirmed after pre-testing in a similar mountainous setting. The final questionnaire was used to gather data on socio-demographic features of the participants, and their information and perception about climate change, extreme weather events and climatic shocks.

The questionnaire was designed with three sections (Socio-demographic variables, perception of climate change, and perceptions of climate-related hazards/shocks) (see Supplementary Appendix-A). The questionnaire sought information on climate change, the impact of climatic hazards/shocks on livelihoods, variation in temperature and rainfall in the last 10–20 years, rainfall occurring time and perceptions of changes in various climatic variables and extreme events. Several strategies were adopted to collect the data. Perceptions of change in various climatic variables for the last 20 years were collected. The criteria for poor and non-poor was based on the standard poverty line as declared by the Planning Commission (Government of Pakistan), that is, 723.40 and 878.64 Pakistani rupees/month/ adult equivalence consumption for the years 2001–02 and 2004–05 respectively. The price of known basic requirements is taken as the poverty line estimation. The package of basic needs consists of food, housing, clothing, education, health, social interaction, transport, and recreation facilities. Poor and non-poor are thus defined as follows (Sadiq, 2007a, 2007b; Shahid, 2010a, 2010b):

Poor: consumption between 75 and 100% of the poverty line.

Non poor: consumption > 125% of the poverty line.

2.4. Analysis of data

Questionnaire data obtained from the household's survey were analyzed using the SPSS software (version 16). Descriptive statistics were used to observe the respondent's socio-demographic characteristics and view on climate change as well as climate related serious shocks on livelihoods. The scores on the socio-demographic characteristics and perception on climate change as well as climatic shocks, were in frequency and percentage form of categorized responses. During the data analysis, associations either supporting or refusing the pre-formulated hypothesis were subjected to statistical tests of significance. For measuring the magnitude/ strength of relationships among different variable, test statistic like Cramer's Value was used. A binary logistic regression and multivariate logistic regression model were developed additionally, in order to examine the possible impacts of each predictor variable on climate change perception.

3. Results and discussions

3.1. Socio-demographic information on Swat rural mountainous population

Most of the respondents age were above 40 years (61%) though, a substantial proportion 39% were below 40 years. All the respondents were recruited from different rural mountain communities of District Swat and 73% of them were married. A sizeable fraction of respondents 42% had education level up to primary and secondary school; about 32% attended intermediate and higher and around one fourth of the respondents are illiterate.

3.1.1. Occupation, income and land ownership of households

The composition for occupation of the respondents showed that around two third 61% depended on crop production for their source of income and were classified as farmers. Service holding was next to farming, which was the livelihood (occupation) of about 32% respondents. Though, only 11% of the respondents were daily laborers, 9% had their source of income from livestock rearing and 5% were associated with firewood selling. With respect to income of the respondents, approximately more than two third 68% had income less than rupees one hundred thousand per year, therefore a substantial proportion 61% were poor. In case of land ownership, 63% respondents owned less than five acres of land.

3.1.2. Respondent's perceptions about climate change and climate related serious shocks

Most of the respondents commonly perceived that climate is changing, resulting in decrease in precipitation amounts, erratic rainfall distribution and rising temperatures for the last few years. From the surveyed area most of the respondents (75%) agreed with regard to the perception of climate change, that climate of the area is changing (Table 2) while rest of the respondents said that there is no change in climate. This result is quite reliable with the baseline study conducted by Practical Action Nepal (2006) and moreover with the study carried out on the farmers by Mengistu (2011) of Ethiopia. Mengistu (2011) studied on farmers, reported that temperature over the previous two decades was rising in Ethiopia. The findings of the baseline study demonstrated that most of the people (98%) had opined a change in climate; whereas 95% among them had perceived that some natural disasters like increasing droughts and erratic rainfall were the main indicators of climate change. Additionally, this percentage (75%) of the present study regarding perception on climate change is quite consistent with the studies carried out by Kemausuor et al. (2011) and Dessai and Sims (2010). Their studies conducted on climate change, concluded that most of the respondents consider that climate is changing. Another study was conducted in South America with respect to climate change by Letson et al. (2001), indicated that less number of respondents (38%) perceive that climate has altered over the last several years. Once more, Anik and Khan (2012) conducted a study in Bangladesh, in some villages of Jamalganj upazila under Sunamganj district. They concluded that only a small number (10%) of the respondents opined that there is change in the climate while the study was carried out on the fishermen, farmers, and petty businessmen who were frequently illiterate. On the contrary, in the current study majority of the respondents (74%) were educated either attended primary school, college or higher (see Table 1), as a result there is a considerable contrast between the results of the

Table 1
Socio-demographic information of the respondents of Swat rural mountain communities (n = 279).

Socio-demographic variables	Number of respondents	Percentage (%)
Age		
< 40 years	108	39
> 40 years	171	61
Marital status		
Married	205	73
Unmarried	74	27
Educational status		
No education	72	26
Primary and high school	118	42
College and Higher	89	32
Occupational structure		
Farmer	170	61
Livestock rearing	25	9
Daily laborer	30	11
Firewood seller	15	5
Service holders	39	14
Income per year (rupees)		
< 1 lac	191	68
> 1 lac	88	32
Land ownership		
< 5 acres	177	63
> 5 acres	102	37
Socio-economic status		
Non-poor	108	39
Poor	171	61

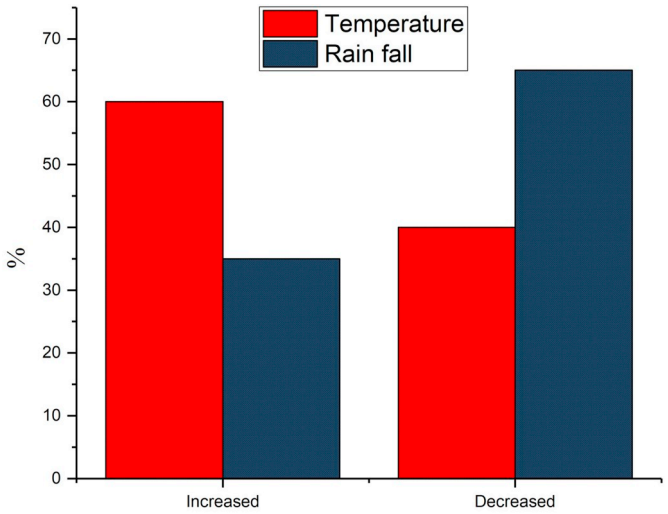

Fig. 2. Response of the respondents about variation in temperature and rain fall in the last 10–20 years.

current study with that of Anik and Khan (2012) study. However, study conducted by Huda (2013) concluded that 71% of the respondents agreed that climate is changing, since a substantial proportion 88.3% of the respondents in his study were educated which can be consider reliable with the present study.

The respondents perceived that climate change also resulted in variety of natural disasters like drought, floods, temperature rise, thunder storm etc. The climate change impacts were been observed by most of the respondents in different sectors of the study area including agriculture, water, air, forests rangelands, livelihoods etc.

3.1.3. Perceptions of respondents on temperature variation

The survey revealed that more than half (60%) of the respondents perceived that there is an increasing trend in temperature over the past two decades in the area. The remaining 40% opinion that there was a declining trend in temperature as shown in Fig. 2. These finding were in line with the results of Gbetibouo (2010) and Mertz et al. (2009) who documented that most of the respondents in three regions of Limpopo River Basin of South Africa and in Eastern Saloum in Senegal, respectively, were having sufficient knowledge of changes in climate patterns mostly increased inconsistency in rainfall. The apparent increase in temperatures in the area were attributed mainly to the reduction of forest capital, increase in population and to so many other factors.

3.1.4. Perception on rainfall trends

The survey findings disclosed that a considerable proportion (65%) of the respondents perceived that the amount of rain fall in the last 10 to 20 years had decreased where only 35% of the respondents documented that it had increased (Fig. 2). The respondents also opined long-lasting variation in precipitation pattern, amount and distribution. These findings were consistent with the study carried out by Gbetibouo (2010) who acknowledged that 81% of farmers in the three regions of Limpopo River Basin of South Africa observed a decreasing trend in precipitation. The present study revealed that farmers had a tendency to perceive decreasing rainfall more than those who are engaged in other occupations. Similar study in Ethiopia on farmers by Deressa et al. (2009) reports role of rainfall forecast information provided to farmers which has enabled them in better selection and timely growing of crops.

3.2. Impacts of climate change on agriculture

The emerging fact revealed during data collection in addition with the past timeline of the area, was irregular and decreasing tendency of pre-monsoon and monsoon precipitation in last few years. Consequently, substantial reduction in the local crop production was noticed. In particular, maize growers were forced to shift toward alternate cropping in recent years owing limited rain-fed land besides infrequent precipitation a major challenge. The other group highlighted impact on wheat crop cultivation however, as an adaptation strategy against reduced rainfall these farmers continue wheat production on irrigated land across the river banks. Evidence of modified local agriculture practices were further provided by poor respondents. Such households with limited income preferred vegetable farming instead of cash crops like maize and wheat, and hence enhance crop diversity in Swat district. Few respondents mentioned selling of their rain fed land and buying irrigated areas close to Swat River to sustain their agricultural livelihood. They further pointed out gradual reduction in winter crops like wheat, corn, potato and barley in recent years owing to lack of rain/snowfall in winter season, which in turn had jeopardized their income. Overall climate driven changes are well perceived by local farmers in Swat district and they demanded government to provide modern water harvesting technologies to cope with this scenario.

Table 2
Respondent's perceptions in percentage on climate change and climate related serious shocks (n = 279).

Perceptions	Number of respondents	Percentage (%)
Is there any climate variability compared to previous years?		
Yes	210	75
No	69	25
Have you observed any variation in temperature in the last 10–20 years?		
Increased	168	60
Decreased	111	40
Have you observed any variation in rain fall?		
Increased	99	35
Decreased	180	65
Does rain fall occurring in time?		
Yes	97	35
No	182	65
Have you encountered any climate related (serious) impacts on your livelihoods?		
Yes	205	73
No	74	27
Do these impacts have negatively affected your cattle farming?		
Yes	167	60
No	112	40
Do these impacts have negatively affected your crop sowing?		
Yes	181	64
No	98	36
Do these impacts have negatively affected your crop harvesting?		
Yes	186	67
No	93	33
What type of climatic shock is your concern?		
Drought	161	58
Shortage of animal feed	48	17
Temperature rise	42	15
High prices of food	19	7
Flood	9	3

3.3. Climate change impacts on livelihood

Climate change impact on population's livelihood in Swat is getting critical primarily because of top two professions (agriculture and livestock), upon which their earning depends are intricately linked to temperature and precipitation variations. Moreover, frequent drought episodes, unseasoned and heavy rains, and pest attacks have resulted in substantial crop failures. All these drivers have led to income reduction and poverty (Shahbaz et al., 2010). Regarding climate shocks, our findings show that Swat population attribute drought (58%), shortage of animal feed (17%), temperature rise (15%), high prices of food (7%), and floods (3%) as highly damaging (Table 2). Respondents further documented that lack of access to services in controlling livestock diseases and poor administration are important constraints that hinders Swat population in coping against climate change impacts. While discussing with experts and community representatives, our survey results were further confirmed that decline in crop and livestock production, shortages in water, food and animal's feed are the key threatening factors for people's livelihood in Swat. To protect ongoing ecological disturbances in Swat (Rashid et al., 2016), urgent intervention by local government was unanimously proposed.

3.4. Perception regarding impacts of climate change on crop production and livestock trend

Out of 71% people associated with agro-based income a large proportion of Swat area population depends on livestock farming (19%) for the livelihood support (Fig. 4). In the former case, we observed a drastic decline in earnings which is confirmed by overwhelming number respondents (57%) who reported recent crop productivity decrease as compared to past few years. Transformation of agricultural land into fallow land seems an important indicator of climate stress as insufficient and untimely rainfall in mountainous areas of Swat has not only posed negative impacts on crops but also forced people to make use of their land for other purpose than agriculture. For instance, we observed a rising trend of small scale animal farming at houses in the study area. On the other hand, from the opinion of large scale cattle farmers it was revealed that 60% of the respondents perceive serious climate impacts on their cattle farming. Since 19% of the people in this region are connected with animal husbandry for their livelihood support, changes in and implications of climate impact livestock farming would have devastating effects on overall socio-economic integrity of Swat population. In response to a question about livestock production trends, 65% answered that livestock production in the region had decreased because of reduced grazing areas (Qasim et al., 2013), livestock diseases and shortage of water required for livestock production.

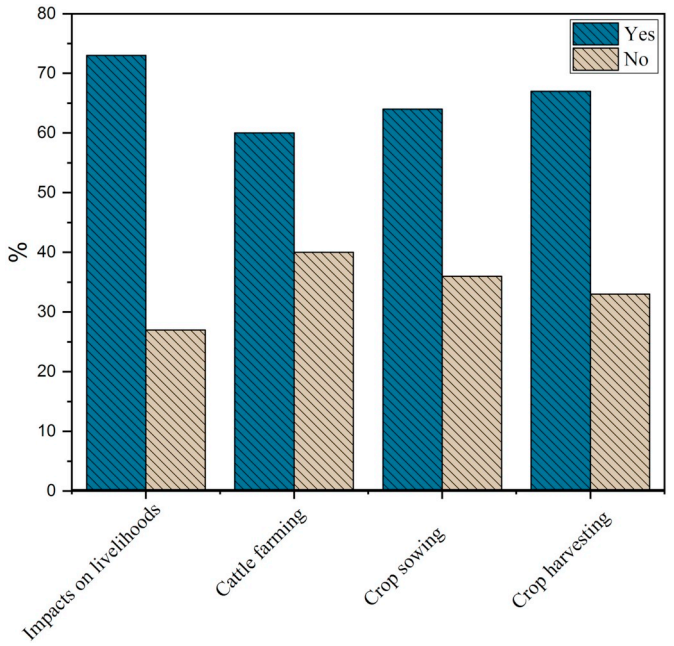

Fig. 3. Response of the respondents on (1) climate related (serious) impacts on your livelihoods; (2) cattle farming; (3) crop sowing and (4) crop harvesting.

3.5. Impacts on crop sowing and harvesting

Agriculture was the major occupation of people living in rural mountainous areas of district Swat. People of the study area did extensive agriculture only for themselves. Crops like wheat, maize and rice were the major food crops. Beside these, they also grown apple, peach, persimmon, apricot, and different vegetables like tomato, potato, onion etc. for their living. The results of household survey data revealed that about two third (64%) of the respondents said that serious climatic impacts have negatively affected on their crop sowing. Further, 67% of the respondents reported negative impacts on crop harvesting (Fig. 3).

3.6. Impacts of climate change on natural resources

Results of the household survey indicated that the drinking water sources (springs and wells) and irrigation water had shown a decreasing trend in the area. The respondents also claimed that the extended drought period, followed by scanty winter precipitation, had not only affected forests and rangelands but also exerted negative effects on grazing of livestock in the area and collection of non-timber forest products (NTFPs). The respondents also reported that livestock production had decreased in the area, followed by a permanent drought in the grazing range lands. Similarly, a growing tendency of timber logging, road construction in different forests and changes in land use cover, mainly from forest to agriculture in the area were documented in all kinds of discussions. This variation in land use cover causes increased emissions of CO_2 into the atmosphere (Ahmad and Nizami, 2015; Ahmad et al.,

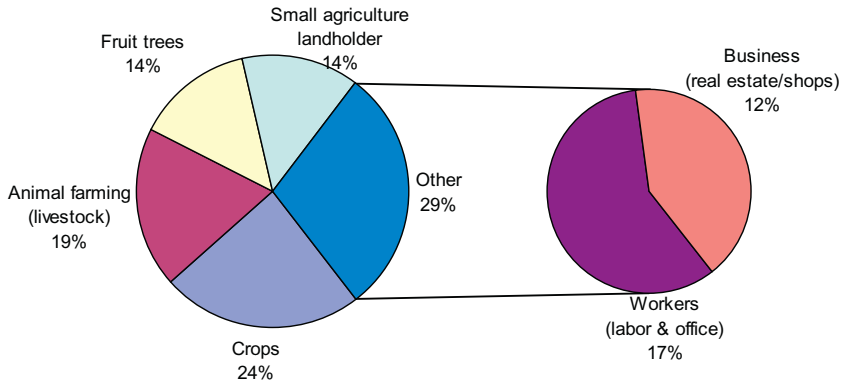

Fig. 4. Income sources of people in Swat with major proportion linked with agro-based income.

2018).The people of mountainous communities reported that owing to small moisture content and over utilization of existing resources, the rearing of livestock had been affected as a result of inadequate and less useful grazing land. Consequently, those people, who more often graze their livestock and couldn't manage to pay for stalk feeding, had condensed their livestock herds. Increased flooding, extended drought period, strong winds, stormy weather and loss of vegetation cover were largely perceived opinions by the people in all the mountainous communities sampled. This perceived opinion corresponds with the study by Manyatsi et al. (2010), in Swaziland.

During the field research, logging of trees without any sort of management in the adjacent forests was also noticed. In the study area, two most important reasons were observed that enhanced the current trend of resource degradation. First, there was an increasing domestic pressure among the communities for the harvesting and selling of forest products including both timber and non-timber, as a coping plan of continued existence after failure of crops again and again. Secondly, increased settlement of people along the high ways was observed in the District following the road access, consuming a high quantity of stones and timber for building purposes. It can be anticipated that the accidental misuse of resources will further speed up resource deprivation and scarceness in the area.

3.7. Relationship between a set of socio-demographic factors and perception on climate change as well as climatic shocks

3.7.1. Association between age, education, occupation, ownership of land, income, socio-economic status and perception on climate change

In the present study, bivariate results recommend that educated people are more likely to perceive the changes in climate as compared to uneducated people. The results also point out that farmers have a tendency to perceive climate change more than any other occupational groups. This is because mostly they are educated and they keep themselves in touch with mass media like radio, newspaper and television. Perception on climate change is again found to be significantly related with other two factors: annual income and ownership of land. The data results indicates that people having < 5 acres of land with annual income of less than one lac rupees are more likely to observe or perceive changes in climate.

The statistical relationship between selected socio-demographic factors and the perception of rural mountainous people on climate change and climatic shocks is shown in Table 3. The findings indicate that age is found to be significantly linked with perception on climate change. It reveals that people with age above 40 years are more expected to see the changes in climate.

3.7.2. Association between selected socio-Demographic Factors and perception on temperature Variation

Temperature was next in significance, which was significantly associated with most of the socio-demographic factors as shown in Table 3.The results showed that age was found to have an association with perception temperature variation. The bivariate table indicated that people with age below 40 years tended more to perceive that temperature had increased than older respondents having > 40 years age.

In terms of education, educated people tended to perceive increased temperature more than illiterate people. Another variable, ownership of land is also linked to hotter temperature perception. The results implied that respondents having < 5 acres of land had a tendency to comprehend temperature increase to greater degree. Occupation was another significant determinant of perception on temperature variation. The findings of the study concluded that farmers are really associated with perception on temperature variation and they perceive more likely about temperature. Income was also found to be statistically significant in view of perception on temperature variation (V = 0.84, $p < .001$). The results suggested that respondents with annual income less than one lac rupees were more likely to perceive about increasing temperature.

3.7.3. Association between perception on decreasing rainfall and Socio- demographic factors

The present study found that age was significantly associated with perception on decreasing rainfall ($p < .001$). Here, the coefficient (V = 0.92) which was a significant value, showed that perceptions of decreasing rainfall were more prevailing among older people (i.e. > 40 years) than those with age below 40 years. Another variable was occupation with (V = 0.58, $p < .001$) which was also significantly related with perception on decreasing rainfall. In case of occupation, study results revealed that farmers had a tendency to perceive decreasing rainfall more than service holders, daily laborers, those selling firewood and rearing livestock. Perception on decreasing rainfall was also associated with annual income (V = 0.49, $p < .001$) and ownership of land (V = 0.55, $p < .001$) that was, people with annual income < 1 lac rupees and with larger piece of land (i.e. > 5 acres) were more expected to

Table 3
Summary table of Cramer′ V value on perception on climate change and climate related shocks.

Socio-demographic variables	Number of respondents	Percentage	Socio-demographic variables	Number of respondents
Cramer′ V value				
Age	V = 0.45***	V = 0.64***	V = 0.92***	V = 0.92***
Education	V = 0.83***	V = 0.85***	V = 0.83***	V = V = 0.83***
Occupation	V = 0.92***	V = 0.81***	V = 0.58***	V = 0.58***
Income	V = 0.84***	V = 0.83***	V = 0.49***	V = 0.49***
Ownership of land	V = 0.75***	V = 0.93***	V = 0.55***	V = 0.55***
Socio-economic status	V = 0456***	V = 0.64***	V = 0.91***	V = 0.91***

***$P = .001$, $P = .01$, $P = .05$.

Table 4
Binary logistic regression for perception of people regarding change in rain fall (predictor is 'decrease in rain fall').

Variable	Beta	SE	Odds ratio	95% CI	*p*-Value
Age					
< 40 years					
> 40 years	1.165	0.261	3.21	1.92–5.34	0.00
Education					
No education					
Primary and high school	0.99	0.310	2.69	1.46–4.94	0.001
College and higher	1.16	0.336	3.20	1.65–6.18	0.001
Income per year (rupees)					
< 1 lac					
> 1 lac	1.41	0.273	4.11	2.40–7.01	0.00
Land ownership					
< 5 acres					
> 5 acres	1.69	0.273	5.44	3.19–9.28	0.00
Socio-economic status					
Poor					
Non poor	1.73	0.273	5.65	3.31–9.64	0.00
Livelihood impacts[a]					
Cattle farming					
No*					
Yes	0.86	0.257	2.36	1.42–3.90	0.001
Crop sowing					
No *					
Yes	0.42	0.259	1.53	0.91–2.53	0.104
Crop harvesting					
No *					
Yes	1.84	0.280	6.33	3.66–10.95	0.00
Overall agro-based income					
No *					
Yes	0.68	0.277	1.98	1.14–3.40	0.014
Water source available water whole year?					
No *					
Yes	0.577	0.253	1.78	1.08–2.92	0.023

[a] Does climate shock (decrease in rainfall) has caused negative effect on following livelihood activities?
* Reference category = no; predictor = yes.

see decreasing rainfall. Socio-economic status of the respondents was also found significant with decreasing rainfall. Data results showed that poor people are more likely to perceive decreasing rainfall than non poor.

3.7.4. Relationship between untimely rainfall and selected socio-demographic factors

It is quite obvious from Table 4, that age, education, occupation, income, ownership of land and socio-economic status had a significant and positive relationship with the respondent's perceptions on untimely rainfall. The results of the study again revealed that age was associated with perception on untimely rainfall that was, older respondents were more expected to comprehend that rainfall was not occurring timely. Occupation had come out as an important feature of perception on inappropriate and untimely rainfall. The results showed that farmers were more likely to perceive that rainfall was not occurring timely than those who were busy in other occupations like NGOs, government servants, daily laborers, those rearing livestock or selling firewood etc. Comparable type of result was found in the study carried out by Deressa et al. (2009) on farmers in Ethiopia. According to their study, perception level of farmers on decreasing rainfall was higher. A strong association between income and untimely rainfall was also found. Annual household income was associated in the study with untimely rainfall perception, i.e. participants having income < 1 lac Rupees were more likely to distinguish untimely rainfall because they consider untimely rainfall one of the causes of their low income. Respondents having higher portion of land had more tendency to perceive about untimely rainfall.

Furthermore, there was also an association between education and perception on untimely rainfall. Respondents having education level up to primary school and higher, were more likely to see untimely rainfall as compared to respondents with higher level of education. This was because respondents with low level of education also engaged directly in agriculture, where as those who do jobs in different non-agricultural sectors namely NGOs, government sectors and education, were not familiar with agriculture. Therefore, low level educated respondents, compared with respondents of other occupational groups, could effortlessly perceive that rainfall was not occurring in proper time when it was essential for their crops.

3.8. Anticipating perception regarding climate change

3.8.1. Rainfall decrease

To calculate perception regarding decrease in rainfall, a regression model of binary logistic was developed. Rainfall decrease was selected as dependent variable and among the independent variables; age was significantly related with the perception that rainfall

has decreased, which indicated that elderly people with above 40 years of age were 3.21 times (95% CI = 1.92–5.34) more incline to perceive decrease in rainfall as compared to the younger (Table 4). With regard to education, findings suggested that respondents with intermediate and higher education level were likely to perceive decrease in rainfall as more prevailing (OR = 3.2; 95% CI = 1.65–6.18) whereas, those having education level up to primary and secondary school were had perceived decrease in rainfall 2.69 (95% CI = 1.46–4.94) times more than illiterate (Table 4).

Another determinant was income which indicated statistically significant association for people having annual income less than one lac (100,000) rupees with perception regarding decrease in rainfall. Similarly, land ownership also had a significant relationship for people having less than five acres of land (OR = 5.44; 95% CI = 3.19–9.28) with perception on rainfall decrease. Regarding socio-economic status of the respondents, results revealed that poor people had projected decreased in rainfall in recent years 5.65 times (95% CI = 3.31–9.64) more than the non-poor (Table 4). The climate change impacts on livelihood practices of the people including cattle farming, crop sowing, crop harvesting and overall agro-based income, all of them are found to be statistically significant with perception on rainfall decrease. In particular, respondents who believe that climate change has negative impact on their cattle farming, perceive rainfall decrease 2.36 times (95% CI = 1.42–3.90) more than those having no such impacts (Table 4). Similarly, for impacts on crop sowing, crop harvesting and overall agro-based income, people from Swat district area perceive 1.53, 6.33, 1.98 and 1.78 times more decrease in rainfall respectively, as compared to those having who experience no such climatic shocks. Sustained availability of water source is another predictor variable, which was recorded as water source available throughout the whole year. Those people who said water source fulfill their water requirement whole year are likely to perceive greater on rainfall decrease than those whose answer was no.

3.8.2. Temperature rise

To investigate perception on temperature that whether it is increasing or decreasing, model of binary logistic regression was developed (Table 5). Dependent variable in this model was “temperature rise” whereas same independent variables were selected which were used for rain fall decrease perception. All the predictor variables used in this model were found to be statistically significant with perception regarding increase in temperature. Findings indicate that elder people are expected to perceive more (2.4 times) on temperature rise as compared to younger people. In terms of education of the respondents, results suggest that educated people are more likely to see changes in temperature (rise) as compared to those having no education.

Income is another determinant of temperature rise, selected in this regression model was also statistically significant. People,

Table 5
Binary logistic regression for perception of people regarding change in temperature (predictor is ‘increase in temperature’).

Variable	Beta	SE	Odds ratio	95% CI	p-value
Age					
< 40 years	0.88	0.253	2.4	1.47–3.97	0.001
> 40 years					
Education					
No education					
Primary and high school	0.63	0.305	1.8	1.03–3.41	0.03
College and Higher	0.48	0.321	1.6	0.86–3.03	0.13
Income per year (Rupees)					
< 1 lac					
> 1 lac	0.96	0.264	2.6	1.55–4.39	0.00
Land ownership					
< 5 acres					
> 5 acres	0.84	0.211	0.4	0.25–0.72	0.00
Socio-economic status					
Poor					
Non poor	0.69	0.139	2	1.22–3.27	0.00
Livelihood impacts [a]					
Cattle farming					
No *					
Yes	0.15	0.234	1.1	0.71–1.89	0.54
Crop sowing					
No *					
Yes	0.42	0.259	1.53	0.91–2.53	0.104
Crop harvesting					
No *					
Yes	1.14	0.317	3.1	1.86–5.25	0.00
Overall agro-based income					
No *					
Yes	0.95	0.208	2.5	1.50–4.45	0.00
Water source available water whole year?					
No *					
Yes	0.88	−0.112	0.4	0.24–0.68	0.00

[a] Does climate shock (increase in temperature) has caused negative effect on following livelihood activities?
* Reference category = no; predictor = yes.

Table 6
Multivariate logistic regression of determinants of rainfall decrease perception in rural mountain community of District Swat.

Variables	Beta	Odds ratio	95% CI
Land ownership	0.43	2.91	1.78–7.87
Socio-economic status	1.31	3.08	1.44–8.13
Livelihood impacts			
Cattle farming	0.59	1.50	0.84–4.11
Crop sowing	0.33	1.08	0.63–5.42
Crop harvesting	1.17	2.19	1.09–6.44
Overall agro-based income	0.45	1.24	0.59–4.81
Water source efficiency	0.51	1.63	1.07–3.82

Note: Adjusted for age, education, income and occupation.

whose annual income was less than one lac rupees, perceive 2.6 times more on increased temperature as compared to those with income above one lac rupees. Similarly, those respondents with land ownership < 5 acres and whose socio-economic status was poor were found significant with perception on temperature rise, with an odds ratio 0.4 (95% CI = 0.25–0.72) and 2 (95% CI = 1.22–3.27), respectively. Furthermore, the impacts of climate change on livelihood practices also showed a significant relationship with temperature rise. People who reported negative impacts on their cattle farming, crop sowing, crop harvesting and overall agro-based income, were more expected to observe changes in temperature (increase) than those having no such kind of impacts. Regarding perception on water source efficiency that whether it provide water whole year or not. Findings indicates also a significant relation with temperature rise with an odds ratio value of 0.4 (95% CI = 0.24–0.68).

3.9. Multivariate regression analysis regarding perception on rainfall and temperature

Multivariate regression model was developed to identify key predictors of rainfall decline perception prevailing in Swat community (Table 6). Our model depicts land ownership, socio-economic status and crop sowing had statistically significant effect on rainfall perception odds ratio = 2.91, 3.08 and 2.19, respectively (Table 6). On the contrary, rest of the variables including cattle farming, crop sowing, agro-based income and water source efficiency had non significant relationship with rainfall decrease perception. In the Table 7, we present model outcomes for temperature rise perception. Here water source efficiency, though had an inverse but significant impact on the perception developed regarding temperature rise (β = −0.73; odds ratio = 0.59; 95% CI = 0.21–0.77). We further observed that land ownership plays a significant role in creating perception of temperature rise having (β = −0.66; odds ratio = 0.39; 95% CI = 0.24–0.85). Similarly, socio-economic status, crop sowing, crop harvesting and total agro-based income had significant impact on perception regarding gradual rise temperature in Swat region.

4. Conclusions

Recent climate shocks including temperature rise, untimely and low rainfall has severely disturbed agriculture in the whole country including Swat, especially in the mountainous areas where this phenomenon was most obvious in recent years. People living in mountains of Swat are unable to adjust their livelihood patterns however, a large portion among them is well aware of climate changes they are confronting with. Our findings show that 75% of the participants, mostly elderly people, perceive natural disasters in their area are induced by climate change. Similarly, people who have education level till college or higher, are likely to see more inappropriate rainfall as compared with participants having no education. In case of annual rainfall amount, a considerable number of people (65%) experience that the total of annual rainfall is showing a decreasing trend each year with diverse rainfall anomalies. To mitigate the climate change impacts in Swat region, awareness and information space relating to the impacts of climate change, insufficient in information broadcasting and knowledge calls for urgent action. Hence we propose local government to play a significant role as promoters, facilitators, guardians and as encourager to build capacity of local communities in adjusting livelihood to better endure impact of climate change and climate shocks.

Table 7
Multivariate logistic regression of determinants of temperature rise perception in rural mountain community of District Swat.

Variables	Beta	Odds ratio	95% CI
Land ownership	0.66	0.39	0.24–0.85
Socio-economic status	0.85	1.88	1.36–4.19
Livelihood impacts			
Cattle farming	0.24	1.29	0.87–2.89
Crop sowing	0.86	2.11	1.22–3.97
Crop harvesting	1.05	2.73	1.69–6.08
Overall agro-based income	0.45	1.24	1.48–5.16
Water source efficiency	−0.73	0.59	0.21–0.77

Note: Adjusted for age, education, income and occupation.

Acknowledgement

This work was financially supported by Higher Education Commission of Pakistan (2011-355492).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.uclim.2018.10.003.

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